REMARKS

Claims 1-12 are all the claims pending in the application. Claims 13-17 have been canceled without prejudice or disclaimer. Reconsideration and allowance of all the claims are respectfully requested in view of the following remarks.

Claim Rejections - 35 U.S.C. § 112

The Examiner rejected claims 1-17 under §112, 1st paragraph, as failing to comply with the enablement requirement. Specifically, the Examiner asserted that the term "or less in terms of Ra" would allow a roughness of "0", which is allegedly not enabled by the specification. Applicants respectfully traverse this rejection because the specification does, indeed, enable one of ordinary skill in the art to make and use the invention as claimed. Implicitly, in the specification as originally filed, by setting forth that the surface has a roughness in terms of Ra, the roughness is greater than 0 μm. Accordingly, Applicants have amended the claims so as to set forth that the surface roughness is greater than 0 μm; i.e. so as to specifically include that which previously was implicit. Accordingly, this rejection is believed to have been overcome.

Claim Rejections - 35 U.S.C. § 102

The Examiner rejected claims 1-17 under §102(b) as being anticipated by US Patent 5,630,668 to Ikezawa et al. (hereinafter Ikezawa). Applicants respectfully traverse this rejection because Ikezawa fails to disclose all of the elements as set forth and arranged in the claims.

The presently claimed invention sets forth a rolling bearing for a roll neck, comprising:

an inner ring having an inner ring race at its outer peripheral surface;

an outer ring having an outer ring race at its inner peripheral surface; and

a taper roller disposed between said inner ring race and said outer ring race,

wherein at least a first one of the inner ring race, the outer ring race, and the rolling surface comprises a first portion with a formed film made of a manganese phosphate, and

wherein at least a second one of the inner ring race, the outer ring race, and the rolling surface comprises a second portion on which there is disposed no formed film but which has a

surface roughness of 0.1 μm or less but greater than 0 μm in terms of Ra, and further wherein said second portion comes into contact with said first portion.

The presently claimed arrangement can exert a great effect particularly when used in an application which is subject to great load and hence smearing or seizing, such as a roll neck bearing for a steel rolling mill.

The rolling bearing for rotatably bearing the roll neck of the rolling mill (hereinafter roll neck bearing) is used in a severe environment such as in high temperature, high and varying load. Further, as the rolling mill operates, foreign matter such as cooling water and rolling scale often enter into an interior of the roll neck bearing to cause mislubrication. Life of the roll neck bearing, which is subject to such severe conditions, is not determined by the rolling fatigue life as seen in ordinary rolling bearings, but is affected by the fatigue accompanying surface damage due to mislubrication or sliding friction. In other words, the roll neck bearing often reaches its life due to fatigue accompanying surface damage before reaching its rolling fatigue life.

In the case of the roll neck bearing, by forming a film on the surface of various members constituting the rolling bearing, the damage and rust of the contact area can be prevented. However, the constituent members which have been merely subjected to forming the film hardly obtain a sufficient effect. The foregoing formed film can be peeled early in the severe operating environment. In accordance with the conventional treatment involving mere film formation, the substrate metal covered by a formed film has a rough surface having a high surface roughness. This is because the surface of the substrate metal is eluted with a solvent during the process of making of the formed film. When this rough surface is exposed as the formed film peels, the effect of preventing rust is lost. Further, the rough surface makes drastic metal contact with its mating surface, causing drastic abrasion that results in damage such as smearing and seizing. Under these circumstances, the present invention was made. It is an aspect of the present invention to provide a roll neck bearing, which has a sufficient durability capable of enduring severe conditions during use.

Smearing is a type of surface damage due to integration of minute seizing generated at a rolling sliding contact portion. It seems that smearing is caused mainly by direct contact of contact faces (metal-metal contact) due to mislubrication or the like. However, there are various

causes of this mislubrication depending on the conditions to which the bearing is exposed during use.

The smearing damage generated at a roll neck bearing will be considered. The roll neck bearing is used with an inner gap between the inner ring and the outer ring. The gap becomes negative due to a temperature difference between that of the inner ring and that of the outer ring. Therefore, the inner gap is set to be large so as to prevent a sharp rise of a heat generated at the bearing. In addition, most of the bearings are lubricated by grease. Further, in order to endure the great load caused by rolling, a very large roller (φ30 to φ 100) is used.

Since the gap is set to be large, a no-load area becomes large. The roll neck bearing is rotating by a friction force just after it goes out from a load area (see Figs. 1-2 of Exhibit A, attached hereto). However, the rotation thereof is gradually reduced by the resistance of the grease or the like and this results in a sharp recovery of the rotation while receiving the load when it enters in the load area again. Then, since an inertia force of the large roller is large, the instantaneous driving force of the roller is also made very large, and the sliding heat becomes high so that smearing is more easily generated as compared to the general bearing.

In addition, there is a repeated releasing and biting of the steel plates in rolling milling. In an unloaded condition, during a releasing operation, the entire bearing is in a no-load area, and sliding at rotation and revolution of the rolling elements are large. On the other hand, in an impact load condition, during a biting operation, there is a recovery of the load area, and the load is applied to the bearing while sliding of the roller is large. In this case of repeated releasing and biting, it is perceived that a large sliding friction is generated and due to heat therefrom, oil film breakdown is caused so that the metal on metal contact is caused. In addition, in repetition of releasing and biting a hot mill steel plate, the bearing repeatedly is subjected to the unload state (sliding of the roller at rotation and revolution is large) and the impact load state (load is applied to the bearing while maintaining sliding of the roller is large), and deterioration of lubrication caused by intrusion of rolled water or the like promote generation of smearing. The patterns of these processes are shown in the attached drawings. See, Fig. 1 of Exhibit A.

Thus, in the roll neck bearing that is used in such severe conditions, smearing is a trouble caused at a high frequency. The content of the present application can exert a great effect as a

countermeasure against this smearing damage of the roll neck bearing. According to one aspect of the present application, at least a first one of the inner ring race, the outer ring race, and the roiling surface comprises a first portion with a formed film made of a manganese phosphate, wherein at least a second one of the inner ring race, the outer ring race, and the rolling surface comprises a second portion on which there is disposed no formed film but which has a surface roughness of 0.1 μm or less but greater than 0 μm in terms of Ra.

The surface roughness is defined to be 0.1 μm or less in terms of Ra because the relatively soft film made of a manganese phosphate is damaged by a metal surface if its surface roughness is more than 0.1 μm in terms of Ra. That is, the upper limit is 0.1 μm in terms of Ra, and as Ra is further decreased, a more advantageous effect can be acquired.

In contrast to that set forth in claim 1, Ikezawa relates to a rolling bearing of a thrust needle type that is suitable when used under an atmosphere that is an alternative chlorofluorocarbon or the like.

This cited reference discloses a roller bearing on which a phosphate surface treatment is performed as a substrate treatment for reduction of friction. In addition, a test sample having the surface roughness of 0.1 in terms of Ra with no surface finishing provided is disclosed.

However, the cited reference independently discloses the bearing having the phosphate treated film as the substrate treatment and the bearing having a surface roughness of 0.1 μm in terms of Ra with no surface treatment provided. That is, the two conditions are not used together in one bearing.

According to that presently claimed, at least a first one of the inner ring race, the outer ring race, and the rolling surface comprises a first portion with a formed film made of a manganese phosphate, and wherein at least a second one of the inner ring race, the outer ring race, and the rolling surface comprises a second portion on which there is disposed no formed film but which has a surface roughness of 0.1 μm or less in terms of Ra. That is, one rolling bearing for a roll neck has both conditions at the same time.

In addition, Ikezawa does not relate to the rolling bearing for a roll neck and has no disclosure regarding to the smearing damage that is specific to the rolling bearing for a roll neck. Accordingly, Ikezawa is not concerned with the same problems as are the present inventors, and

thus would not have found the same solutions as reside in the surface characteristics of parts of the bearing.

Stated another way, one aspect of the present invention is a combination of a specific surface having a manganese film and another specific surface having a defined surface roughness but not having the film. This combination is not disclosed in Ikezawa. Therefore, the presently claimed invention is not obvious over the cited reference.

For at least any of the above reasons, Ikezawa fails to anticipate independent claim 1. Likewise, this reference fails to anticipate dependent claims 2-5.

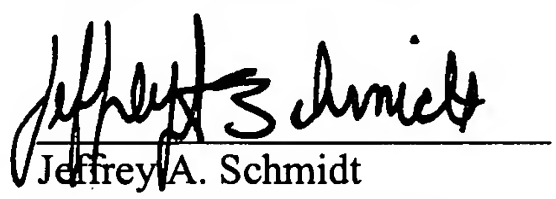
Independent claim 6, similarly to claim 1, sets forth at least one of the inner ring race, the outer ring race, and the rolling surface comprises a first portion which is comprising a smoothed formed film made of a manganese phosphate, and wherein at least a second one of the inner ring race, the outer ring race, and the rolling surface, comprises a second portion on which there is disposed either a formed film, or no formed film but a surface roughness of 0.1 μm or less but greater than 0 μm in terms of Ra. Accordingly, for reasons similar to those set forth above with respect to claim 1, Ikezawa fails to anticipate independent claim 6. Likewise, this reference fails to anticipate dependent claims 7-12. Applicants have canceled claims 13-17 and, therefore, this rejection is believed to be moot with respect those claims.

Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



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